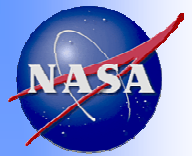




Human Health & Support Systems Capability Roadmap

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Requirements and Objectives



Reduce Risk

NASA shall implement a safe , sustained and affordable robotic and human program to explore and extend human presence across the solar system and beyond.

Level 0 Exploration Requirements for NASA

For Human Explorers to undertake lengthy research trips on other worlds, they will have to maintain their health in environments that possess higher radiation and lower gravity than Earth that are far from supplies and medical expertise.

The Vision for Space Exploration

The successful development of identified enabling technologies will be critical to attainment of exploration objectives within reasonable schedules and affordable costs.

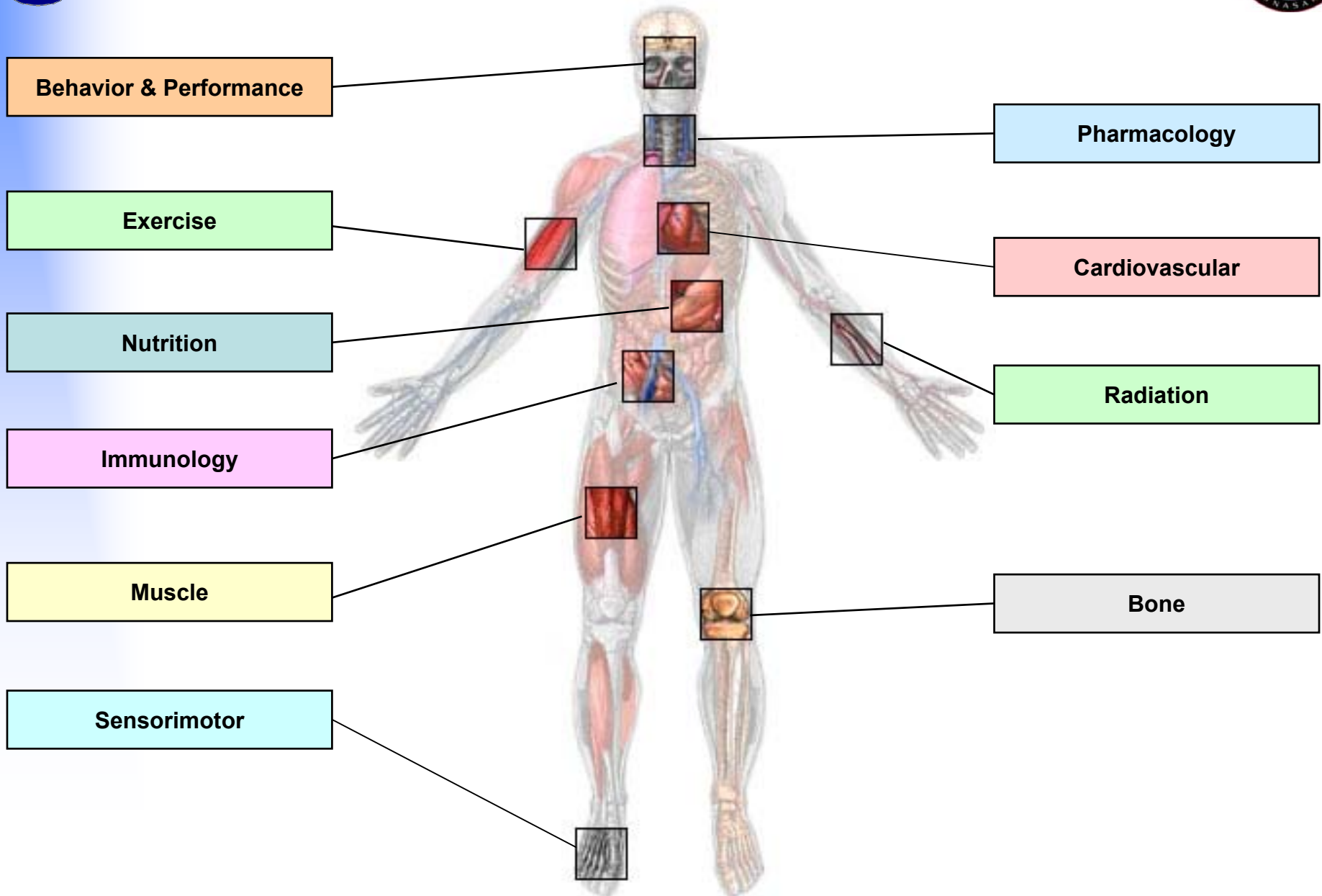
Biomedical risk mitigation – space medicine; remote monitoring, diagnosis and treatment.

Excerpt from "Report of the President's Commission on Implementation of United States Space Exploration Policy," June 2004

Increase Capability



Effects of Space Flight on Humans





Human Health Capabilities



➤ Autonomous Medical Care

- Prevention
- Monitoring
- Diagnosis
- Treatment

➤ Radiation

- Measurement Technologies
- Shielding Solutions
- Shielding Concepts/Recommendations



Support Systems Capabilities

- Life Support and Habitation
 - Air Revitalization
 - Water Reclamation
 - Thermal Control
 - Solid Waste Management
 - Food Management System
 - Biomass Production
- Environmental Monitoring and Control (Vehicle, lunar and Mars surfaces)
 - Air, Water, Surface Monitoring
 - External Environment Monitoring
 - Life Support Integrated Controls
 - Fire Prevention, Detection, Suppression
- Exploration Habitats (lunar and Mars)
 - Surface Construction
 - Habitat Shell
 - Internal Systems and Outfitting
 - External Systems and Architecture



Extra-vehicular Activity (EVA) Capabilities

- Extra-vehicular Activity (in space and lunar and Mars surface)
 - EVA suits
 - Portable Life Support Systems
 - Airlock
 - EVA Tools



Capability Categories and Examples

- Categories of deliverables and operational experience
 - **Knowledge:** *reducing radiation uncertainties, DCS risk estimation*
 - **Standards:** *permissible exposure limits for bone loss; operating bands, SMACs, habitability, crew screening and selection criteria*
 - **Requirements:** *exercise, shielding, nutrition, artificial gravity*
 - **Countermeasures:** *exercise protocol, pharmacological regimen, medical certification*
 - **Assessment/diagnostic and treatment tools:** *health maintenance criteria, post-landing rehab, models, diagnostic tools*
 - **Training and credentialing:** *expert systems, in-flight operational training, ground training*
 - **Inflight medical protocols:** *medical hardware for cardiopulmonary and trauma life support, risk-based diagnostic and treatment capabilities, emergency life support capabilities*
 - **Design tools:** *tools to model complex mission tasks and productivity*
 - **Technologies:** *sensors/monitors/instruments, informatics, food packaging*
 - **Components/subsystems/systems:** *EVA suit, water quality sensor suite, countermeasures suite*